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Science and Technology for Tomorrow's Air and Space Force

Success Story

REVOLUTIONARY TEST METHOD FOR KISSING BONDS ENSURES STRONG ADHESION FOR HIGH-PERFORMANCE AIRCRAFT AND CIVIL STRUCTURES

A revolutionary test method will speed up certification of adhesively bonded composite materials for widespread usage in aircraft construction. This certification will allow adhesively bonded structures to compete economically with traditional riveted aluminum structures.

Additionally, this new technology allows aircraft designers to use the distinctive properties of composite materials to great advantage in highly original and efficient aircraft designs. New lighter, stronger, and more efficient adhesively bonded design concepts are no longer constrained by traditional joining methodologies.

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Accomplishment

Dr. Robert L. Crane, a scientist in the Materials and Manufacturing Directorate, found a way to detect both nonexistent bonds, or kissing bonds, and weak or low-strength bonds while performing research on the detection of high-cycle fatigue damage in the first-stage compressor blades of an F-100 jet engine. Dr. Crane's discovery will allow technicians to test adhesive bonds for mechanical performance nondestructively during manufacturing and depot-level repair.

The technology employed in the new testing method works wherever manufacturers use adhesive bonding, with composite and metal as well as hybrid composite and metal structural components. This new testing method is so effective at identifying kissing bonds, it could easily make composites the material of choice for most high-performance aircraft and civil structures. Other major application areas for composite materials affected by this technological advance are spacecraft, automobiles, prostheses, and sports equipment.

Background

A kissing bond refers to a condition in adhesive bonding where there is intimate contact between the adhesive and the structure or component, but no adhesion between these two entities. Inspectors traced a sizeable number of premature service failures to kissing bonds. Consequently, aircraft designers were reluctant to use adhesive bonding in primary or flight-critical structures, despite the advantages of this joining technique.

Since the 1950s, the nondestructive inspection community within the United States searched intently to find any technique capable of predicting bond performance and detecting kissing bonds. Two challenges stopped progress towards this goal.

First, manufacturers most often use methods restricted to areas that carry little or no structural loads when detecting these defects. Second, from an ultrasonic inspection point of view, there is no difference between a kissing bond and a coherent bond because both are in intimate contact and, therefore, undetectable with ultrasonic methods. Even if inspectors can detect kissing bonds, it is still possible for a low-strength bond to slip through the inspection process and result in unexpected structural failures.

The directorate and the Boeing Company, which is currently patenting the technology, jointly conducted the research that validated this concept. Since the discovery of this new testing approach, several organizations have expressed intense interest in using the new method for the inspection of primary or critical bonds.

Additional information

To receive more information about this or other activities in the Air Force Research Laboratory, contact TECH CONNECT, AFRL/XPTC, (800) 203-6451 and you will be directed to the appropriate laboratory expert. (03-ML-16)

Materials and Manufacturing
Emerging Technologies